January 27, 1999

MEMORANDUM

SUBJECT: **REVISION OF EXPOSURE ASSESSMENT FOR DICHLORVOS (DDVP) APPLIED TO GREENHOUSES AND MUSHROOM HOUSES (D251337, PC Code 084001)**

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1.0 INTRODUCTION

In April 1998 exposure assessments were conducted for the use of dichlorvos (DDVP) in greenhouses and mushroom houses (1). The assessments assumed that either hand held foggers or total release smoke generators are used for application to greenhouses. Mushroom house application was considered to be made using a hand held fogger, coarse spray, or by paintbrush. HED has received notification from Special Review Branch that the registrant, AMVAC Chemical Corporation, is voluntarily deleting applications using a hand held fogger. That document is presented in Appendix A.

In addition, subsequent to the production of that document, the Health Effects Division Exposure Scientific Advisory Council (EXPOSAC) has generated a series of generic transfer coefficients to be used in lieu of data for a number of reentry scenarios. These

coefficients are presented in Appendix B. These transfer coefficients are different from those used in the earlier 1998 assessment.

The exposure assessment has been revised to reflect these changes. Other parameters used in the assessment have not changed. The calculations and the rationale behind the calculations for reentry from the previous document are repeated in this document for clarity.

2.0 CONCLUSIONS

HED has provided revised earlier estimates of workers applying DDVP in greenhouses and mushroom houses based on changes in application and reentry parameters that have become evident since production of the exposure assessment of April 1998. Explanations of the quality of data and the methods by which estimates were derived are presented below. An explanation of the uncertainties associated with each scenario is also included**.** The exposures for all of the scenarios are summarized in Table 1.

Greenhouse

The only methods of application of DDVP to greenhouses that were previously allowed were by hand held fogger and by use of total release smoke generators. The former method has been voluntarily withdrawn from the technical label (see Appendix A). Smoke generators of the type used for DDVP are units which are ignited by the applicator who immediately leaves the facility. Exposure under these conditions is considered to be negligible.

Exposure estimates for workers were reentering a greenhouse were derived from the combination of a literature study (for the dermal component) and models using ventilation information obtained from a greenhouse operation textbook. Air flow information, described in detail in Section 4.2 was used to derive a series of first order decay equations under various conditions, considered to representative of normal greenhouse operations. The estimated respiratory exposures from these scenarios were combined with an estimate of the dermal transfer coefficient obtained from a study in the scientific literature to yield a total exposure. The exposure estimates are presented in Table 1.

The post application dermal exposures for greenhouse workers were derived from foliar dislodgeable values obtained from a study in which a DDVP/Chlorpyrifos mixture was sprayed on lawns, not fogger application to a greenhouse. It is not known what the actual deposition of DDVP would be on the foliage after actuation of a smoke generating product. The deposition of DDVP from a smoke generator was assumed to be the same as that from the spray study. It is also not known whether the dissipation patterns are similar for these two formulation/application scenarios. The transfer coefficients for greenhouse and mushroom house activities were obtained from the generic transfer coefficient table published by the Health Effects Division Exposure

Advisory Council (EXPOSAC), presented in Appendix B. The estimated transfer coefficient for greenhouse reentry is assumed to be 10000 cm^2/hr. The estimated dermal exposures for reentry to greenhouses are also presented in Table 1.

Mushroom Houses

Application

DDVP can be applied to mushroom houses by coarse spray or using paint on methods. The data for coarse spray application DDVP to mushroom houses are very limited. They were obtained from limited data from the Pesticide Handlers Exposure Database (PHED) V1.1 and ranged from 9 to 13 replicates, depending on application equipment. **These are considered to be low confidence data sets (2).**

The estimates of the amounts of DDVP to be handled and surface areas treated were obtained using information found in a mushroom culture textbook. These parameters may not be applicable for all sites. In lieu of specific data it was necessary to use very conservative assumptions, particularly with regard to the surface areas of beds, tables, and walls of mushroom houses, which would be the areas treated by coarse spray applicators or those using paintbrushes for application.

The estimate of postapplication exposure to mushroom workers was obtained from a very limited study measuring surface residues and air concentrations in 2-4 mushroom house over a 24 hour period. **The very limited data used to obtain the estimates and the resulting uncertainties must be considered when making any regulatory judgements regarding these uses.** As was the case for greenhouses, the transfer coefficients were obtained from the EXPOSAC document presented in Appendix B. The transfer coefficient for mushroom houses is assumed to be 2500 cm^2/hr.

Table 1. Summary of Exposures of Workers to DDVP During and Following Application to Greenhouses or Mushroom Houses.

Site	Clothing	Total Daily Exposure (mg/kg/day)	NOEL (mg/kg/day)	MOE
Greenhouse Post Application	No protective clothing	0.023 if entering after 2 hours of ventilation; 0.0023 if entering after 10 hours of ventilation	0.5	22 after 2 hours; 217 after 10 hours
Mushroom House Coarse Spray Application	Long pants, Long sleeve shirt, gloves	0.0035 to 0.024	0.1	4.2 to 28
Mushroom House Coarse Spray Application	Long pants, Long sleeve shirt, gloves, respirator (90% protection)	0.0016 to 0.022	0.1	4.6 to 62.1
Mushroom House Paint Application	Long pants, Long sleeve shirt, gloves	NO DATA but not expected to exceed spray application.	NO DATA but not expected to exceed spray application.	NO DATA but not expected to exceed spray application.

Mushroom House **Post Application**	No protective clothing	0.0088 if entering after 12 hours of ventilation; 0.0052 if entering 24 hours of ventilation	0.5	57 after 12 hours; 96 after 24 hours

3.0 USE AND LABEL INFORMATION

HED has an estimate of the use of DDVP in greenhouses from a 1985 memorandum received from BUD (3). An average ornamental crop (carnations, chrysanthemums, or roses, etc.) takes about 16 weeks per crop. It is believed that DDVP would not be applied more than once a week and no more than 3 times per crop. This would yield a short term exposure scenario with a NOEL of 0.5 mg/kg/day (4). The target MOE for short term exposures is 10.

Of the previously existing labels listed in Appendix C for greenhouse/mushroom house use only 2 are currently allowed by the technical label. One is a smoke generating product and this label is still valid. The other specifies that the chemical is to be applied as either a coarse spray or painted on surfaces in mushroom houses only.

4.0 GREENHOUSE EXPOSURES

4.1 Greenhouse Applicator Exposure

4.1.1 Fogger Application

Since the deletion of hand held foggers from the technical label application of DDVP to greenhouses is allowed only by smoke generator. Smoke generators and other total release foggers are assumed to provide negligible exposure to the applicator since the applicator is required to exit the facility immediately upon igniting the smoke generators. Likewise automatic foggers would be considered to have negligible applicator exposure, although there may be potential for mixer/loader exposures. No such products are registered for greenhouses at this time. Any exposure in a greenhouse scenario would be from reentry.

The use report for DDVP (3) indicates that an average greenhouse has the dimensions of 120 feet in length, 48 feet wide, 10 feet high at the walls, and 20 feet at the roof peak. The estimated volume was 85,000 ft^3. A typical operation was assumed to consist of 7 greenhouses which could be treated in a single day. Treatment was estimated to be 3.75 minutes per house or 26 minutes (0.44 hrs) per day. Treatment would not be expected to occur in a given greenhouse more than once a week, resulting in an acute exposure scenario. The appropriate NOEL would be 0.5 mg/kg/day (4).

4.2 Greenhouse Post Application Exposure

4.2.1 Greenhouse Post Application Dermal Exposure

HED has no data addressing surface residues of DDVP in the greenhouse

environment. The only dislodgeable foliar residue data available were from a study found in the public literature following application of DDVP to a home lawn. The study description is presented below.

DISLODGEABLE RESIDUES OF DDVP ON TURF

CITATION: Goh, K.S, S. Edmiston, K.T. Maddy, D.D. Meinders and S Margetich (1986) Dissipation of Dislodgeable Foliar Residue of Chlorpyrifos and Dichlorvos on Turf. Bull. Environ. Contam. Toxicol., 37:27-32.

Dislodgeable residues of chlorpyrifos and dichlorvos were measured in turf plots located in Sacramento County. Six 0.61 m x 2.44 m plots of healthy Kentucky bluegrass were sprayed at 700 AM with an insecticidal formulation containing 2.6% DDVP and 3.0% chlorpyrifos (ë0.25 lb ai per gallon for each component. The material was applied at the maximum label rate of 3.79 L of product in 605 L of water for 508 m^2 (5466 ft^2) of lawn. Immediately after spraying, three of the plots were watered with one half inch of water. Leaf samples were collected before application, immediately after treatment, and at intervals of 2, 6, 10, 24, 48, 72, and 96 hours. Two randomly selected samples of approximately 8 grams each were obtained from each plot and immediately stored on ice until transfer to the analytical laboratory.

Since it is much easier to measure leaf weight than area, a linear regression correlation equation was used to determine the correlation of leaf weight to surface area. Leaf samples weighing 2 to 18 grams and weighed to the nearest centigram. A single surface leaf area was determined for each sample using a leaf area meter (LI-COR, Nebraska). The linear regression equation, forced through the origin, was Y = 79.28 X with an r^2 of 0.99.

Dislodgeable residues were determined by rotating the leaf samples three times (30 minutes each) once with 0.2 mL of 2% Sur-Ten Solution, once with 50 mL water with Sur-Ten, and finally with 50 mL of water alone. The 150 mL solution was extracted three times with 50, 25, and 25 mL ethyl acetate, the solvent phase was dried over sodium sulfate. The sample solutions were analyzed by gas chromatography with a detection limit of 1_g per sample.

The DDVP dislodgeable foliar residue level was 0.10 _g/cm^2 immediately after application (<2 hrs). After 2 hours the level in the non-irrigated plots had dropped to approximately 0.04 _g/cm^2 (Confidence interval ë0.32 to 0.05 _g/cm^2). Levels remained at approximately these levels at the 6 hour interval. By 10 hours the levels had dropped to ë0.004 _g/cm^2. Dissipation was faster in the plots that had been watered but were also at levels of ë0.004 _g/cm^2 after 10 hours. No material was detected after the 24 sampling period.

The dislodgeable foliar residue level of DDVP was 0.10 _g/cm^2 immediately after application (<2 hrs). After 2 hours the level in the non-irrigated plots had dropped to approximately 0.04 _g/cm^2 (Confidence interval ë0.32 to 0.05 _g/cm^2). Levels remained at approximately these levels at the 6 hour interval. By 10 hours the levels had dropped to ë0.004 _g/cm^2. Dissipation was faster in the plots that had been watered but were also at levels of ë 0.004 _g/cm^2 after 10 hours. No material was detected after the 24 sampling period.

In order to estimate dermal exposure from dislodgeable residues, a transfer factor is necessary. The previously used transfer coefficient was obtained from a literature study in which pesticide exposures were monitored during the harvesting of flowers in the Netherlands (5). The estimated transfer coefficient was 4500 cm²/hr. A default value of 10000 cm^2/hr has been selected by the EXPOSAC for greenhouse reentry (see Appendix B) and has been used for this revised exposure assessment.

Additional assumptions were used to estimate the total dermal exposure of these workers:

1) A worker was assumed to weigh 70 kg.

2) Workers were assumed to work 8 hours in the greenhouse.

3) At least 7 days were assumed to lapse before DDVP would be reapplied, resulting in no buildup on the foliage.

4) The dermal absorption of DDVP is 11 percent (4).

5) A greenhouse is ventilated for at least 2 hours before reentry.

6) The deposition and dissipation pattern of DDVP on greenhouse foliage is the same as that resulting from spraying of residential turf.

The total daily dermal exposure that would occur is estimated to be:

Dermal Exposure (ög/kg/day) = DFR (ög/cm²) x 10000 (cm²/hr) x 8 hrs/day x 0.11 x 1/70 kg

The dermal exposure estimates for these workers are presented in Table 2.

Table 2. Estimates of Dermal Exposures of Workers Reentering Greenhouses Treated with DDVP.

Time After Start of Ventilation	Dislodgeable Foliar Residues (ög/cm²)	Daily Dermal Exposure (ög/kg/day)[1]	Daily Dermal Exposure (mg/kg/day)
<2 hours	0.10	13	0.013
2 -6 hours	0.04	5	0.005
10 hours	0.004	0.5	0.0005

[1]Dermal Exposure (ög/kg/day) = DFR (ög/cm²) x 4500 (cm²/hr) x 8 hrs/day x 0.11 x 1/70 kg

4.2.2 Post Application Respiratory Exposure - Greenhouses

HED has no adequate data measuring the air concentrations resulting from application of DDVP in greenhouses. It was therefore necessary to use models to estimates these concentrations. It was assumed that the air concentration under ventilated conditions followed first order kinetics and that the initial concentration (C_o) was the maximum label rate from the LUIS report of 2 g/1000 ft^3. After 1 air change this concentration would be halved at time, $t_{1/2}$. The rate constant (k) for first order decay can be calculated by the equation:

$$k = 0.693/t_{1/2}$$

HED has obtained reference air exchange rates from a textbook (6) which are presented for various conditions of vent position and wind speed in Table 3. Ventilation requirements for greenhouse operation vary depending on environmental conditions. Although these conditions cannot be standardized, a worker performing tasks in a greenhouse would be expected to be exposed to a decreasing concentration of airborne DDVP. The post application exposure of greenhouse workers to DDVP has been considered to be a short term scenario with a NOEL of 0.5 mg/kg/day (4). To yield a MOE of 10 the exposure would be 0.05 mg/kg/day. The dermal component, after 2 hours of ventilation was estimated to be 0.005 mg/kg/day (above), leaving 0.045

mg/kg/day for respiratory exposure. If 70 kg worker works 8 hours per day with a respiratory volume of 1.7 m^3 per hour the concentration necessary to yield an MOE of 10 would be:

Exposure (mg/kg/day) = Conc (mg/m^3) x 1.7 m^3/hr x 8 hrs/day â 70 kg

$$\text{Conc } (mg/m^3) = \frac{0.045 \text{ mg/kg/day} \times 70 \text{ kg}}{1.7 \text{ m}^3/\text{hr} \times 8 \text{ hrs/day}}$$

$$= 0.23 \text{ mg/m}^3$$

Estimates of the appropriate reentry times were derived by inserting the k values from Table 3 into a spreadsheet and calculating the concentrations over time for each of the aeration scenario. It was assumed that the initial concentration (C_0) was the maximum label application rate of 2 g per 1000 ft^3 (71 mg/m^3). The estimates are presented in Table 4. In all of the aeration scenarios, with the exception of both sides and roof shut, the concentrations dropped below the target of 0.23 within 60 minutes after the beginning of aeration. The highest concentration calculated after 2 hours of aeration was 0.19 mg/m^3 (shaded area in Table 4). The estimated respiratory component of exposure would be:

Exposure (mg/kg/day) = 0.19 mg/m^3 x 1.7 m^3/hr x 8 hrs/day â 70 kg

= 0.037 mg/kg/day

4.2.3 Total Exposures and Calculation of MOE

The calculation of total exposures assumes that there are 2 hours of ventilation prior to reentry. The estimated dislodgeable residues measured after 6 hours in a limited study were similar to those after 2 hours (Table 2).

Table 3. The Effect of Wind Speed and Ventilator Position on Air Exchange in the Greenhouse (9).

Vent Position		Wind Speed (mph)	Air Exchanges per hour	Minutes per Air Change ($t_{1/2}$)	Decay constant (k)
Roof	Sides				
Shut	Shut	13.4	2.9	21	0.033
Lee side 1/4 open	Shut	13.3	9.1	6.6	0.105
Both sides full open	Shut	2.7	14	4.3	0.161
Both sides full open	Open	1.4	41	1.5	0.462
Both sides full open	Open	1.9	45	1.3	0.533
South side opens at 64_ F	Shut	6.2	8.6	7.0	0.099
North at 80_ F	Shut (warmer day)	5.3	8.7	6.9	0.100
Both sides full open	Shut	6.0	20	3.0	0.231
Both sides full open	Shut	6.5	34	1.8	0.385

Table 4. Estimated Concentrations of DDVP in Greenhouses Under Different Conditions of Aeration.
The target concentration to yield a short term MOE of 100 is 0.026 mg/m³.

Roof Position	Shut	Lee Side 1/4 Open	Both Sides Full Open	Both Sides Full Open	Both Sides Full Open	S. Side Opens at 64_ F	N. Side at 80_ F	Both Sides Full Open	Both Sides Full Open
Sides Position	Shut	Shut	Shut	Open	Open	Shut	Shut	Shut	Shut
Wind Speed	13.4	13.3	2.7	1.4	1.9	6.2	5.3	6.0	20
Air Exchanges per hr	2.9	9.1	14	41	45	8.6	8.7	20	34
Decay Constant, k	0.033	0.105	0.161	0.462	0.533	0.099	0.1	0.231	0.385
Time (min)	**Estimated Concentrations (mg/m³):**								
0	71.0000	71.0000	71.0000	71.0000	71.0000	71.0000	71.0000	71.0000	71.0000
10	51.0436	24.8456	14.1920	0.6995	0.3439	26.3819	26.1194	7.0475	1.5109
20	36.6964	8.6944	2.8368	0.0069	0.0017	9.8029	9.6088	0.6995	0.0322
30	26.3819	3.0425	0.5670	0.0001	0.0000	3.6425	3.5349	0.0694	**0.0007**
40	18.9666	1.0647	0.1133	0.0000	0.0000	1.3535	1.3004	**0.0069**	0.0000
50	13.6355	0.3726	0.0227	0.0000	0.0000	0.5029	0.4784	0.0007	0.0000
60	9.8029	0.1304	0.0045	0.0000	0.0000	0.1869	0.1760	0.0001	0.0000
70	7.0475	0.0456	0.0009	0.0000	0.0000	0.0694	0.0647	0.0000	0.0000
80	5.0667	0.0160	0.0002	0.0000	0.0000	0.0258	0.0238	0.0000	0.0000
90	3.6425	0.0056	0.0000	0.0000	0.0000	0.0096	0.0088	0.0000	0.0000
100	2.6187	0.0020	0.0000	0.0000	0.0000	0.0036	0.0032	0.0000	0.0000

110	1.8826	0.0007	0.0000	0.0000	0.0000	0.0013	0.0012	0.0000	0.0000
120	**1.3535**	**0.0002**	**0.0000**	**0.0000**	**0.0000**	**0.0005**	**0.0004**	**0.0000**	**0.0000**

5.0 MUSHROOM HOUSE

5.1 Applicator Exposure

HED has no data directly measuring the exposures of applicators using DDVP in mushroom houses. Products requiring fogger application have been deleted leaving one product for mushroom house application. This label directs the user to apply a 0.5 percent solution at a rate of 1/2 to 1 pint per 100 ft^2 either as a coarse spray or by painting the product on surfaces with a brush. A retreatment is not specified in the other labels. Earlier labels allowed retreatment every four days or twice a week. These intervals were used for establishment of the appropriate NOAEL. Mushroom house application is considered to be an intermediate exposure scenario with a NOAEL of 0.1 mg/kg/day.

The specifications of mushroom houses are slightly different than those for greenhouses. A typical mushroom operation is believed to consist of 10 houses, each with a volume of 30000 ft^3 (850 m^3) (3).

HED has no data regarding the surface areas of mushroom houses in the United States. A mushroom house has an volume of 30000 ft^3 (850 m^3). The volume of a typical mushroom house in the Netherlands is 342 m^3 (12073 ft^3)(7). The surface areas of the floors, walls, and ceiling of these houses is 348 m^2 (3744 ft^2) with a growing volume of 5 beds. Each of these growing beds has an internal dimensions of 13.8 m x 1.34 m x 0.18 m, giving an internal surface area of:

Surface Area (m^2) = 2[(13.8 m x 0.18 m) + (1.34 m x 0.18 m)]

= 5.5 m^2 = 59 ft^2

The total area of a house with a volume of to be sprayed would be:

Total Area (ft^2) = 3744 ft^2 + 5(59 ft^2) = 4039 ft^2

In lieu of specific data, HED has assumed that the ratio of the volume to area sprayed would be the same for mushroom houses in the United States and those in the Netherlands. Since mushroom houses in the United States are about 2.5 times larger (30000 ft^3/12073 ft^3) the estimated area sprayed or painted would be:

Estimated Area (ft^2) = 4039 ft^2 x 2.5 = 10098 ft^2

HED notes that this may be conservative for a painting scenario because not all areas are easily painted but has no data with which to refine this estimate.

The spray/paint product (Appendix A) is used as a 0.5 percent solution (w/w) containing approximately 0.67 oz ai per gallon (and applied at a rate of ½ to 1 pint per 100 ft². Therefore, the maximum volume to be applied to a mushroom house would be:

Amount per house (gal/house) = 1 pt/100 ft² x 10098 ft²/house x 1 gal/8 pts

= 12.6 gallons per house

If the concentration of ai is 0.67 oz (0.042 lb ai) per gallon, the amount applied per house would be:

Lb ai/house = 12.6 gallons/house x 0.042 lb ai/gallon

= 0.53 lb ai/house

The daily amount handled for someone treating 10 houses is therefore 5.3 lb ai/day. This is probably conservative for the painting because painting such an area would be difficult in one day. It would be possible to spray such an area, although this may be unlikely to occur.

It is not certain exactly what type of coarse spray equipment would be used in any particular mushroom house. The equipment used could vary from a hose end sprayer to backpack to a pinpoint compressed air apparatus depending on the growers needs. HED has reassessed these exposure estimates using the Pesticide Handlers Exposure Database (PHED V1.1). Both the applicator file (APPL.FILE) and mixer/loader/applicator file were examined. Low pressure hand wand and high pressure hand wand were considered to be low confidence data (2).

The 1993 assessment included a number of application methods that are no longer on the DDVP label for mushroom houses and has eliminated the studies addressing these obsolete scenarios from the current assessment. Revised estimates using PHED have replaced these studies. Studies were selected manually from the PHED system in order to obtain those that most closely match the mushroom house application scenario

A table of the application method, estimated unit exposures, clothing scenarios, and data sources is presented in Table 5. PHED outputs are presented in Appendix D.

The daily exposures and resulting MOEs estimated for these workers to DDVP, adjusted for use information and dermal absorption are presented in Table 6. It must be noted that the respiratory measurements for three of these studies are based entirely on non-detect samples and therefore have an artifactual component, possibly an appreciable one.

Table 5. Estimates of Unit Exposures of Workers Applying Pesticides Using Various Types of Equipment That Might Be Used for Coarse Spray in a Mushroom House. These values are NOT corrected for dermal absorption. Numbers in parentheses are in mg/kg, adjusted for a 70 kg worker.

Equipment Used	Clothing Scenario	Unit Exposure - mg/lb ai (mg/kg/lb ai)		No. Of Reps	Reference
		Dermal	Respiratory		
Hand Held Sprayer	Long Pants, Long Sleeves, Gloves	0.17 (0.0024)	0.026[1] (0.0004)	9	PHED (471LPHW.MLAP)
Backpack Sprayer	Long Pants, Long Sleeves, Gloves	2.6 (0.37)	0.026[1] (0.0004)	9	PHED (471PKPK.MLAP)
Backpack Sprayer	Long Pants, Long Sleeves, Gloves	0.27 (0.0039)	0.062 (0.0009)	4	PHED (416.APPL.APPL)
Portable Sprayer on Wheels	Long Pants, Long Sleeves, Gloves	0.69 (0.0099)	0.078[1] (0.0011)	9	PHED(471.APPL)

[1] All values were non-detect samples

Table 6. Estimates of Daily Exposures and Resulting MOEs of Workers Applying DDVP Using Various Types of Equipment That Might Be Used for Coarse Spray in a Mushroom House. These values are corrected for a dermal absorption of 11 percent.

Equipment Used	Clothing Scenario[1]	Amount Handled (lb ai per day)	Unit Exposures[2] (mg/kg/lb ai)		Daily Exposure (mg/kg/day)		Total Exposure (mg/kg/day) .	NOEL (mg/kg/day)	MOE
			Dermal	Resp.	Dermal[3]	Respir.			
Hand Held Sprayer	LP, LS, G	5.3	0.0024	0.0004	0.0014	0.0015	0.0029	0.1	34.3
Backpack Sprayer	LP, LS, G	5.3	0.37	0.0004	0.022	0.0015	0.023	0.1	4.3
Backpack Sprayer	LP, LS, G	5.3	0.0039	0.0009	0.0023	0.0036	0.0059	0.1	17
Portable Sprayer on Wheels	LP, LS, G	5.3	0.0099	0.0011	0.0058	0.0045	0.010	0.1	9.7

[1] LP = long pants, LS = long sleeve shirt, G = gloves

[2] Assumes a 70 kg worker

[3] Daily Dermal Exposure = Amount Handled (lb ai/day) x Unit Exposure (mg/kg/lb ai) x 0.11 (Absorp)

5.2 Post Application Exposures in Mushroom Houses

There are few data addressing the post application of workers to DDVP in mushroom houses. The California Department of Food and Agriculture (CDFA) conducted a limited air and surface monitoring study of mushroom houses in California (15) which is described below. As explained in Section 4.2.2 the total exposure required to reach a MOE of 10 would be 0.05 mg/kg/day.

CITATION: Maddy, K. T., F. Schneider, J. Lowe, E. Ochi, S. Fredrickson, and S. Margotich (1981) Vapona (DDVP) Exposure Potential to Workers in Mushroom Houses in Ventura County, California in 1981. HS-861.

Air residue samples were collected from four mushroom houses treated with Vapona (DDVP) at a rate of 34 grams per 16,000 ft^3. Surface wipe samples of horizontal surfaces were collected from two such rooms. The material was by placing a container of the pesticide on a hot plate located in the center of the room. The doors were closed and the interior forced air fans run for 20 minutes. After the application the exhaust fans were run at high speed for 30 minutes. Following 30 minutes of aeration, during which there were 10 air changes, the workers were allowed to reenter the building without protective clothing.

Air samples were collected by drawing air at a rate of 1 liter per minute through XAD-4 resin tubed using personal sampling pumps. Samples were obtained prior to applications and at intervals of 30 minutes, 1 hour, 3 hours, 6 hours, 12, hours and 24 hours after the treatment. The duration of the 30 minute sample was 30 minutes and the a 1 hour interval was used for the others.

Wipe samples were collected from the upper tiers of the houses which workers must climb to irrigate the mushrooms. Areas were measured with a template and swabbed with laboratory tissues moistened with ethyl acetate.

Both air and wipe samples were stored on ice for shipment to the analytical laboratory where they quantified by gas chromatography.

The results of air sampling are presented in Table 5 and graphically in Figure 1. The results of surface sampling are in Table 6.

Table 5. Air Concentrations of DDVP in Mushroom Houses After Application at a Rate of 34 grams per 16,000 ft^3. Values are in ppm. Numbers in parentheses have been converted to mg/m^3.

	Room 4	Room 6	Room 52	Room 124	Mean

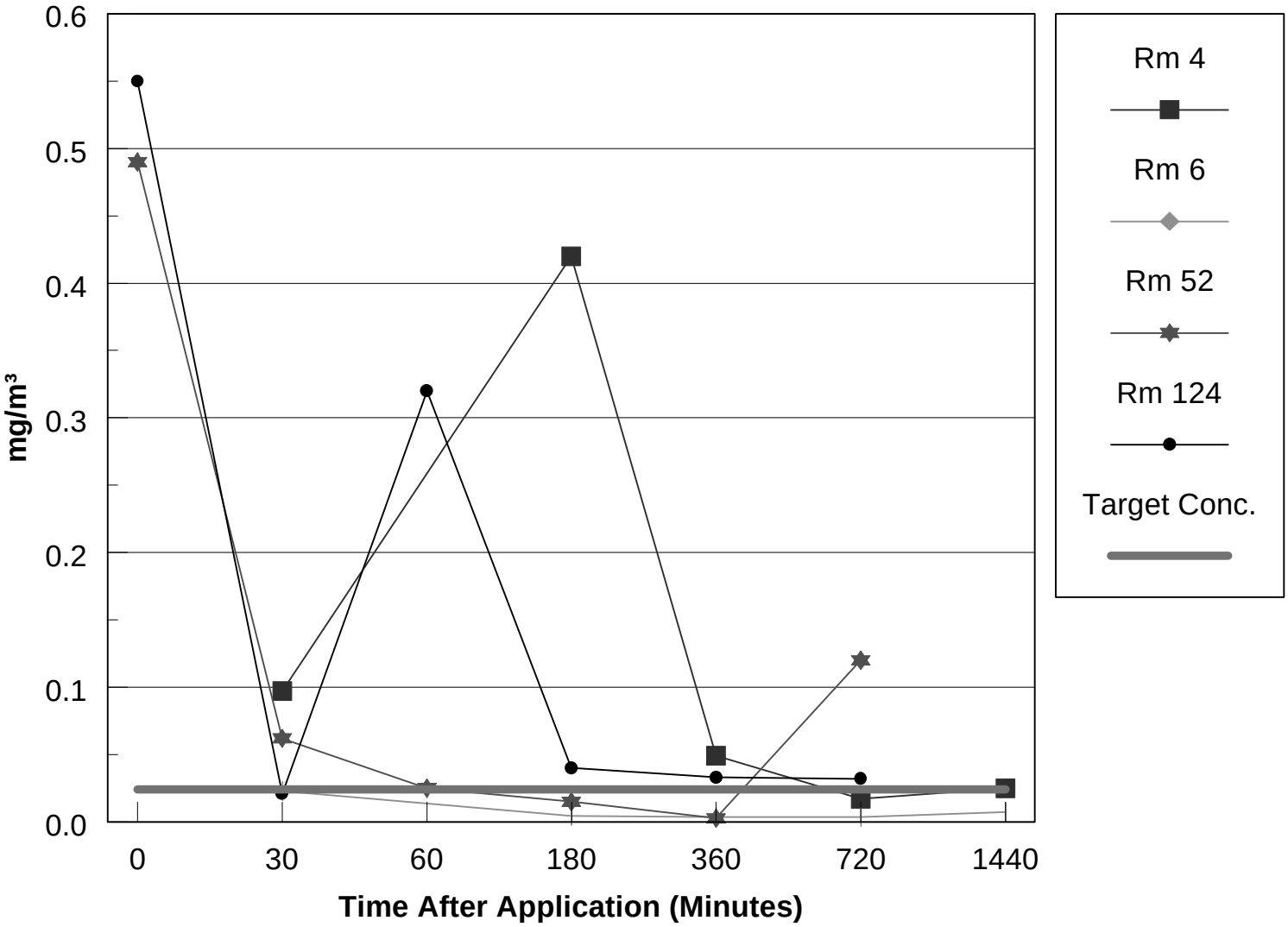
Preapplication	ND	ND	ND	ND	ND
During Application	No sample	No sample	0.054 (0.49)[1]	0.061 (0.56)	0.058 (0.53)
30 minutes	0.0107 (0.097)	0.0025 (0.023)	0.0068 (0.061)	0.0023 (0.021)	0.0056 (0.051)
1 hour	No sample	No sample	0.0028 (0.025)	0.0035 (0.032)	0.0032 (0.029)
3 hours	0.0046 (0.042)	0.0005 (0.0045)	0.0017 (0.015)	0.0044 (0.040)	0.0028 (0.026)
6 hours	0.0054 (0.049)	0.0004 (0.036)	0.0003 (0.0027)	0.0037 (0.033)	0.0025 (0.022)
12 hours	0.0019 (0.017)	0.0004 (0.036)	0.0134 (0.12)	0.0037 (0.033)	0.0049 (0.044)
24 hours	0.0028 (0.025)	0.0008 (0.0072)	No sample	No sample	0.0018 (0.016)

[1]mg/m^3 = 221 g/mol â 24.25 x ppm

Table 6. Surface Residues of DDVP in Mushroom Houses After Application at a Rate of 34 g per 16000 ft³. Values are in ög/cm².

	Room 52	Room 124
Preapplication	ND	ND
30 minutes post-application	0.014	0.007
3 hours post-application	0.026	0.003
12 hours post-application	0.014	ND

Figure 1. Airborne Concentrations of DDVP in Mushroom Houses



5.2.1 Postapplication Dermal Exposure

HED has no data measuring a transfer coefficient for workers performing tasks in mushroom houses. HED has used the transfer coefficient for low crops of 2500 cm² per hour, obtained from the table presented in Appendix B. Surface residues were obtained from a limited study conducted by the California Department of Food and Agriculture (CDFA, now CALEPA). Wipe sampling was only conducted in 2 mushroom houses, preventing any analysis of the distribution of surface residues in these facilities. Therefore the highest residues monitored were used for the estimation of dermal exposure. There was no clear trend with which to describe the dissipation over a 12 hour period. A surface residue of 0.026 ög/cm², the highest residue measured, was therefore used to estimate dermal exposure. This may be conservative since the wipe samples were collected using an organic solvent (ethyl acetate) instead of the

more commonly used surfactant rinse used in dislodgeable foliar residue studies. However, in lieu of additional data, HED must take a conservative approach. The resulting dermal exposures of a 70 kg worker working 8 hours per day in a treated mushroom house are estimated to be:

Dermal Exposure (ög/kg/day) = 1000 cm^2/hr x 8 hr/day x 0.026 ög/cm^2 x 1/70 kg x 0.11 (Absorb)

= 0.33 ög/kg/day = 0.00033 mg/kg/day

Postapplication Respiratory Exposure

Postapplication respiratory exposures were derived from the study summarized in Section 5.2. The total exposure required to generate a MOE of 100 is 0.005 mg/kg/day for an acute exposure scenario. If the dermal component is subtracted from this total the maximum "allowable" respiratory exposure would be 0.0047 mg/kg/day. For a 70 kg worker working 8 hours in a mushroom house with a respiratory volume of 1.7 m^3 per hour, the maximum concentration would be:

Exposure (mg/kg/day) = Conc (mg/m^3) x 1.7 m^3/hr x 8 hrs/day â 70 kg

$$\text{Conc (mg/m}^3\text{)} = \frac{0.0047 \text{ mg/kg/day} \times 70 \text{ kg}}{1.7 \text{ m}^3\text{/hr} \times 8 \text{ hrs/day}}$$

= 0.024 mg/m^3

Calculation of MOEs

12 Hour Reentry

Respiratory Exposure

The total exposure of a 70 kg worker in a mushroom house entering the facility after 12 hours is estimated to be:

Daily Respiratory Exposure (mg/kg/day) = 0.044 mg/m³ x 1.7 m³/hr x 8 hr/day â70 kg

= 0.0085 mg/kg/day

Added to the dermal component gives:

Daily Exposure = 0.0085 mg/kg/day + 0.00033 mg/kg/day

= 0.0088 mg/kg/day

The corresponding MOE for these workers using a short term NOEL of 0.5 mg/kg/day would be:

$$\text{MOE} = \frac{0.5 \text{ mg/kg/day}}{0.0088 \text{ mg/kg/day}}$$

$$= 57$$

24 Hour Reentry (Using the highest of the 2 values reported for air concentration)

Daily Respiratory Exposure (mg/kg/day) = 0.0018 mg/m³ x 1.7 m³/hr x 8 hr/day â70 kg

= 0.0049 mg/kg/day

Total Daily Exposure = 0.00495 mg/kg/day + 0.00033 mg/kg/day

= 0.0052 mg/kg/day

The corresponding MOE for these workers using a short term NOEL of 0.5 mg/kg/day would be:

$$\text{MOE} = \frac{0.5 \text{ mg/kg/day}}{0.0052 \text{ mg/kg/day}}$$

= 96

It is evident from Table 6 and Figure 1 that the air concentrations fluctuate greatly during the 24 hours following treatment. Two of the four rooms monitored showed increases in the airborne DDVP concentration after 1-3 hours. This may be due to off-gassing of DDVP from the compost following treatment or release of “pockets” of material due to the nature of mushroom house construction. Examination of the very limited data from the study indicates that in the two study rooms reported, the concentrations are 0.025 and 0.0072 mg/m^3. Based on this very limited data the target concentration of 0.024 m/m.^{3} was not achieved until after 24 hours and only 2 samples were provided. There are at this time insufficient data to revise the reentry intervals of 48 hours described in the PD 2/3 (7). Additional data could refine this estimate.

REFERENCES

1) Memorandum from D. Jaquith (EAB) to C. Scheltema (RCAB) titled “EXPOSURE ASSESSMENT FOR DICHLORVOS (DDVP) APPLIED TO GREENHOUSES AND MUSHROOM HOUSES (D246129, PC Code 084001), dated April 22, 1998.

2) PHED Surrogate Exposure Guide, May 1997.

3) Memorandum from M. Dow (BUD) to D. Pilitt (RD) titled “DDVP (Vapona) QUA”, dated October 2, 1985.

4) Federal Register Notice, September 28, 1995, Dichlorvos; Notice of Preliminary Determination to Cancel Certain Registrations and Draft Notice of Intent to Cancel; Page 50352.

5) Van Hemmen, J.J, R. Brouwer, and D.H. Brower (1992) Worker Exposure to Pesticides in Greenhouses Health Risks During the Harvesting of Flowers. Med. Fac. Landbouww. Univ. Garn. 57/3b.

6) Mastalerz, J.W (1977) The Greenhouse Environment. John Wiley & Sons, New York, Table 2.1, page 14.

7) Arkenbout, J. (1988) Air Treatment in Mushroom Growing IN: The Cultivation of Mushrooms, L.J.L.D van Griensven, Ed. Darlington Mushroom Laboratories Ltd, Rustington Sussex, England.

cc: DDVP File/084001
Correspondence file
D. Utterback (SRB/7508W)
S. Hummel (CEB2/7509C)

APPENDIX A

AMVAC CHEMICAL CORPORATION™
2110 DAVIE AVENUE, CITY OF COMMERCE, CALIFORNIA 90040
(323) 264-3910 FAX (323) 887-9221

FACSIMILE MESSAGE : TOTAL PAGES 14

Mr Dennis Utterback
Special Review Manager
Special Review and Reregistration Division, 7508W
US Environmental Protection Agency
401 M Street SW
Washington, D.C. 20460

Fax: 703-308-8041

Tel: 703-308-8026

Date: 19 August 1998

SUBJECT: VOLUNTARY DELETIONS OF USES ON THE DDVP TECHNICAL LABEL

Dear Dennis,

AMVAC is voluntarily deleting the following uses from the DDVP technical label:-

Hand-Held Fogger use ✓

Outdoor Fogger use ✓

Dry Bait Formulation use around Homes, Cabins and Residential Lawns ✓

Food Service Establishments (excluding non-food/feed servicing areas): restaurants, cafeterias, taverns, delicatessens, mess halls, school and institutional dining areas, hospitals, mobile canteens, vending machines, groceries and markets.

If you require any further information then please give me a call on (323)526-2384.

Regards,

Ann Manley

Director of Toxicology

Cc Eric Wintemute
David Cassidy
Bill Feiler
Ian Chart
Jon Wood

Bob Gilbane

980819xam01/ddvp:us:reg

APPENDIX B

Policy
Science Advisory Council for Exposure

Policy #: 003
Regarding: Agricultural Default Transfer Coefficients
Date: May 7, 1998
Index terms: Transfer coefficients; default; re-entry; dermal exposure

ISSUE:

There is a need to assure consistency in the default transfer coefficients used when no other information is available.

BACKGROUND:

This is a reference for reviewers when no agricultural postapplication exposure data are available. Its purpose is to add consistency to the choice of default transfer coefficients under such circumstances. It is designed particularly for agricultural workers. The generic default values in the table below are not supported quantitatively, but were derived by pesticide exposure assessors, based on their best judgement from their experience with the transfer coefficients used for these crops and agricultural activities in pesticide-specific assessments.

POLICY:

Use the following table as a guide for choosing default transfer coefficients when no other supporting data or information are available:

APPENDIX B

Table 1. Default Transfer Coefficients for Agricultural Activities

Crop Group/Site	Activities	Default Transfer Coefficient (cm^2/hr)
Low Potential for Dermal Transfer (*see Table 2 below*)	harvest (*hand*)	2,500
	scout irrigate	1,000
Medium Potential for Dermal Transfer (*see Table 2 below*)	harvest (*hand*) stake/tie scout irrigate	4,000
High Potential for Dermal Transfer (*see Table 2 below*)	harvest (*hand*)	10,000
	stake/tie scout irrigate	4,000
Turfgrass	mow, maintain	1000
	cut/roll/harvest (*sod farm*)	10,000
Grapes	harvest, hand girdle, cane, tie prune, thin, tip	15,000
	irrigate	4,000
Tree crops (*fruit and nut*)	all activities, e.g., harvest (*hand*) prune, summer shake, rake, pole and pickup (*nuts*) prop	10,000

APPENDIX B

Ornamentals, indoor	cut/harvest (*e.g., flowers*) prune (*e.g., roses*)	10,000
	irrigate	4,000
	sort/pack	2,500
Ornamentals, outdoor (*shrubs, trees*)	transplant ball/burlap	10,000
	sort/pack	2,500
	irrigate	4,000
Mushrooms	cut/harvest/sort/pack	2,500
Tubers, onions	dig/harvest by hand	10,000
	sort, pack	2,500
cotton	scouting, early season	1000
	scouting, late season	4000
All	hoe, weed	1,000
	till, disc plant mechanically build furrows harvest mechanically (*only refers to machine operators; not to any manual activities ancillary to the machine harvest*)	NA, negligible Tc likely
	plant by hand; aligning plants(*e.g.*, *potato pieces; sugar cane*)	10,000

Use the following table as a guide for choosing crops:

APPENDIX B

Table 2. Examples of Crops for use in Table 1.

LOW Dermal Transfer	MEDIUM Dermal Transfer	HIGH Dermal Transfer
Alfalfa	Beans, Bush	Bananas (*unbagged*)
Artichokes	Caneberries and Bushberries	Beans, Pole
Asparagus	Cantaloupe	Corn
Bok Choy	Cranberries	Tomato
Broccoli	Cucumbers	
Brussels Sprouts	Eggplant	
Cabbage	Gourds	
Celery	Herbs, medium-growing	
Chick Peas	Melon	
Collards	Okra	
Herbs, low growing	Peanut	
Kale	Pepper	
Lettuce	Pumpkin	
Mustard Greens	Rice	
Pineapple	Squash	
Small grains (*negligible to low due to mechanical harvesting, e.g., barley, wheat, oats*)	Strawberries	
	Zucchini	
Spinach		
Swiss Chard		
Watercress		

APPENDIX C - LABEL INFORMATION

Product	Use Site	Percent DDVP	Application Parameters	Max Rate	Retreatment Interval	PPE
Amvac DDVP 5 for Mushroom Houses EPA No. 5481-203	Mushroom House	50	2% solution (1 pt to 2-3/4)gal trichloroethane; ULV Cold aerosol generator; expose 1 hr; ventilate with fans before resuming work); direct fog downward while walking backwards through building; Keep fogger nozzle at least 6 to 8 feet from the beds	5 g/1000 ft^3	Twice weekly during spawn run; thereafter as required; do not apply within 1 day of harvest	Coveralls w/long sleeve shirt and long pants, chemical resistant gloves, chemical resistant footwear, socks, protective eyewear, chemical resistant headwear for overhead exposure, chemical resistant apron while cleaning equipment or M/L, respirator with organic vapor cartridge w/ prefilter or canister approved for pesticides
Air-Mate Formula GH-19 EPA No. 5011-49	Greenhouse/ Mushroom House	9.3	**GREENHOUSE:** Close all doors, windows, and ventilators; lock all entrances,; turn off misting systems etc.; foliage should be dry; use in Dyna-Fog only (Pulse fogger); walk backward down center of aisle, swaying machine from side to side	32 oz/96000 ft^3		Full face mask approved for dichlorvos
			MUSHROOM HOUSE: Walk down center of aisle, directing fog upward; ventilate at least 1 hour before re-entering	2 oz/3000 ft^3		Full face mask approved for dichlorvos

APPENDIX C - LABEL INFORMATION

Summit Mushroom House Fogging Insecticide EPA No. 6219-21	Mushroom House	9.3	Close all windows and doors; Apply dry fog; recommended flow rate is 8 oz per minute REI = 24 hours	2 oz/3000 ft^3	Every 4 days	Coveralls over long sleeved shirt and long pants, chemical resistant gloves, chemical resistant footwear plus socks, protective eyewear, chemical resistant headgear for overhead exposure, chemical resistant apron when cleaning equipment or M/L, respirator with organic vapor-removing cartridge with a prefilter approved for pesticides

APPENDIX C - LABEL INFORMATION

Prentox Vapon 4E EPA No. 655-692 (for use in PA only)	Mushroom House		Apply with brush or as a coarse, wet spray to inside walls, around doors, ventilators and cracks in building before mushrooms come into production; ½-1 pint per 100 ft^2	0.5 percent solution	Not Specified	Not Specified
Fulex DDVP Fumigator EPA No. 1327-36	Greenhouse	11.09	Close greenhouse vents prior to use; do not place on wood or flammable materials placing the farthest 10 feet from end of greenhouse and others equidistant throughout length of the greenhouse; light generators, staring with farthest from the exit; when all cans are ignited, exit immediately	0.61 oz (17 g) per 10000 ft^3	One or two repeat applications at intervals of about one week	Coveralls over long sleeve shirt and long pants, waterproof gloves, chemical resistant footwear and socks, protective eyewear, chemical resistant headgear for overhead exposure, respirator with either an organic vapor-removing cartridge with a prefilter for pesticides or a canister approved for pesticides

Appendix D. Summary Statistics for Studies Selected from PHED to Address the Exposures of Workers to DDVP in Mushroom Houses.

471 - Low Pressure Hand Wand

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	DISTRIB. TYPE	MICROGRAMS PER LB AI SPRAYED Median	Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	Lognormal	13.52	95.9689	161.5896	37.513	9
NECK.FRONT	Lognormal	4.065	7.3967	116.9075	4.327	9
NECK.BACK	Normal	1.144	2.7243	101.6775	1.9155	9
UPPER ARMS	Normal	15.132	29.9407	99.9395	22.7111	9
CHEST	Other	18.46	146.26	242.8398	34.8928	9
BACK	Other	18.46	66.9372	201.2858	29.0838	9
FOREARMS	Other	6.292	6.292	0	6.292	9
THIGHS	Other	19.864	37.9878	115.1859	27.6737	9
LOWER LEGS	Lognormal	12.376	66.9309	164.3135	30.0241	9
FEET						0
HANDS	Other	2.0833	2.0833	0	2.0834	9
TOTAL DERM:		169.6884	111.3963	462.5218	196.5164	
INHALATION:	Other	26.0417	26.0417	0	26.0429	9
COMBINED:		195.7301	137.438	488.5635	222.5593	

95% C.I. on Mean: Dermal: [-8383.8174, 9308.861]
95% C.I. on Geo. Mean: Inhalation: [26.0429, 26.0429]
Inhalation Rate : 25 Liters/Minute Number of Records: 9
Data File: MIXER/LOADER/APPLICATOR Subset Name: 471LPHW.MLAP

471 - High Pressure - Greenhouse and Ornamentals

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES

SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	DISTRIB. TYPE	MICROGRAMS PER LB AI SPRAYED Median	Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	Lognormal	105.69	140.8333	77.4664	105.262	9
NECK.FRONT	Lognormal	12.195	22.0817	96.0397	13.4678	9
NECK.BACK	Lognormal	8.943	31.548	152.5041	12.9288	9
UPPER ARMS	Other	45.396	47.918	15.7895	47.4874	9
CHEST	Other	55.38	55.38	0	55.3791	9
BACK	Other	55.38	55.38	0	55.3791	9
FOREARMS	Lognormal	18.876	255.0142	248.3883	47.5413	9
THIGHS	Lognormal	59.592	4954.0307	291.5219	186.603	9
LOWER LEGS	Lognormal	37.128	3474.1124	283.7355	159.2327	9
FEET						0
HANDS	Other	6.25	110.8403	266.2583	13.8807	9
TOTAL DERM:	687.4416	404.83	9147.1386		697.1619	
INHALATION:	Other	78.125	78.125	0	78.1277	9
COMBINED:	765.5666	482.955	9225.2636		775.2896	

95% C.I. on Mean: Dermal: [-352402.5151, 370696.7923]

95% C.I. on Geo. Mean: Inhalation: [78.1277, 78.1277]

Inhalation Rate : 25 Liters/Minute Number of Records: 9

Data File: APPLICATOR Subset Name: 471.APPL

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES

SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	DISTRIB. TYPE	MICROGRAMS PER LB AI SPRAYED Median	Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	Lognormal	70.46	383.0956	194.8378	79.1674	9
NECK.FRONT	Lognormal	15.93	119.965	155.5213	26.7717	9
NECK.BACK	Lognormal	663.894	1349.5607	97.8202	849.1595	9
UPPER ARMS	Lognormal	27.354	12277.5487	216.2146	234.3196	9
CHEST	Other	18.46	230.4739	223.1428	42.3181	9
BACK	Lognormal	3272.745	10793.8144	149.0355	1242.0996	9
FOREARMS	Other	6.292	151.5323	208.7399	20.6347	9
THIGHS	Lognormal	19.864	597.2782	282.8189	49.147	9
LOWER LEGS	Lognormal	32.13	425.8878	230.6324	64.6874	9
FEET						0
HANDS	Lognormal	2.0833	4.9821	130.0415	3.3199	9
TOTAL DERM:	2573.4241	4129.2123	26334.1387		2611.6249	
INHALATION:	Other	26.0417	26.0417	0	26.0429	9
COMBINED:	2599.4658	4155.254	26360.1804		2637.6678	

95% C.I. on Mean: Dermal: [-617117.5802, 669785.8576]

95% C.I. on Geo. Mean: Inhalation: [26.0429, 26.0429]

Inhalation Rate : 25 Liters/Minute Number of Records: 9

Data File: MIXER/LOADER/APPLICATOR Subset Name: 471BKPK.MLAP

416 Greenhouse backpack

SUMMARY STATISTICS FOR CALCULATED DERMAL EXPOSURES
SCENARIO: Long pants, long sleeves, gloves

PATCH LOCATION	DISTRIB. TYPE	MICROGRAMS PER LB AI SPRAYED Median	Mean	Coef of Var	Geo. Mean	Obs.
HEAD (ALL)	Lognormal	16.25	27.0725	95.3133	20.1332	4
NECK.FRONT	Lognormal	4.995	5.31	48.4614	4.8351	4
NECK.BACK	Lognormal	4.5815	14.4348	154.0181	5.4415	4
UPPER ARMS	Lognormal	42.9225	42.9225	50.4938	38.6002	4
CHEST	Other	29.465	29.465	0	29.465	4
BACK	Lognormal	44.375	44.375	38.798	41.7961	4
FOREARMS	Lognormal	52.151	107.5992	134.3206	41.6344	4
THIGHS	Lognormal	53.289	58.828	55.412	51.985	4
LOWER LEGS	Lognormal	19.754	22.253	22.4599	21.8835	4
FEET						0
HANDS	Lognormal	10.5833	25.5625	123.344	15.957	4
TOTAL DERM:	271.731	278.3663	377.8225		271.731	
INHALATION:	Lognormal	31.25	31.8742	62.4728	26.7416	4
COMBINED:	298.4726	309.6163	409.6967		298.4726	

95% C.I. on Mean: Dermal: [-4512.6214, 5268.2664]
95% C.I. on Geo. Mean: Inhalation: [6.6448, 107.6198]
Inhalation Rate : 25 Liters/Minute Number of Records: 4
Data File: APPLICATOR Subset Name: 416.APPL.APPL